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ABSTRACT

Provided in this glossary is an alphabetical list of approximately 300 terms used in science and technical education. The definition or meaning of each term as it is commonly used in these fields is included. The purpose of the glossary is to promote more complete and precise communication between science/technical education specialists and laymen, and among the specialists themselves. In addition, the meanings of approximately 70 abbreviations (acronymns) of scientific/technical organizations and curriculum projects are provided. (JN)

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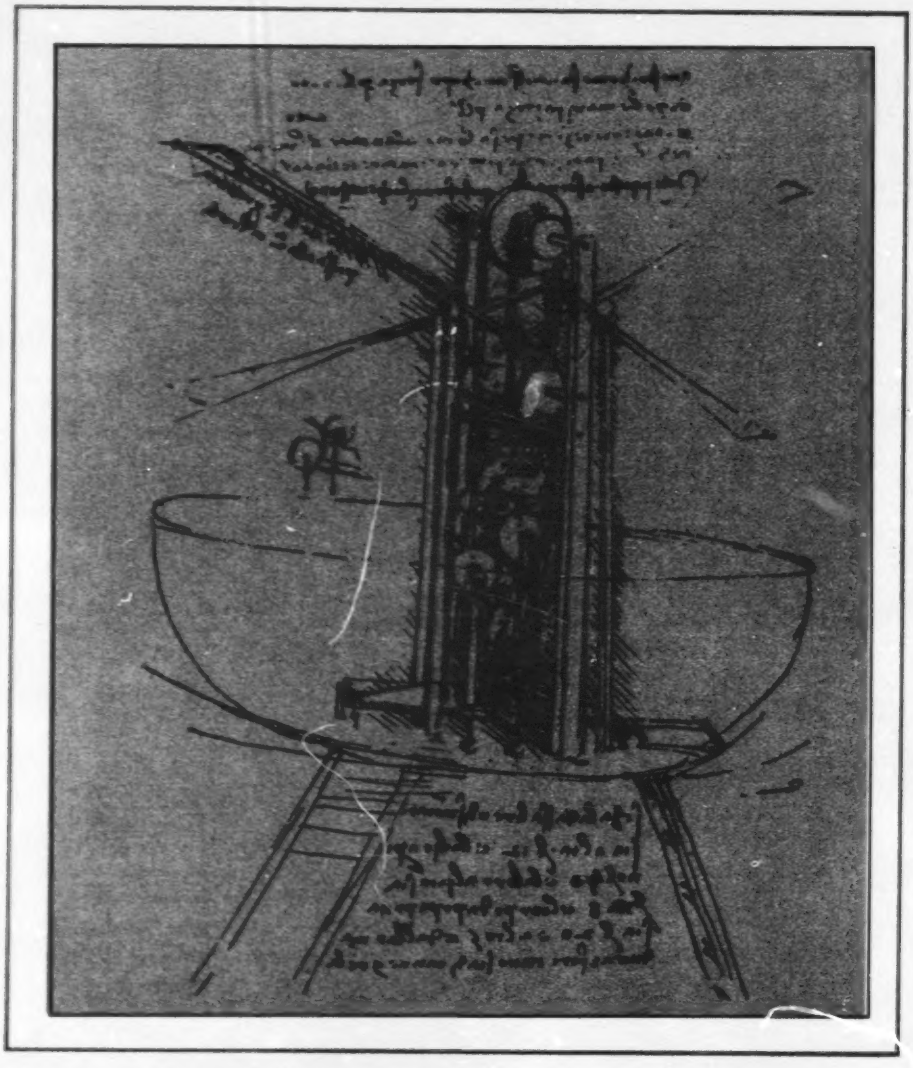
glossary of terms used in science and technology education



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SCIENCE AND TECHNOLOGY EDUCATION
DOCUMENT SERIES

Number 1

GLOSSARY OF TERMS USED IN SCIENCE AND TECHNOLOGY EDUCATION

Division of Science, Technical
and Vocational Education

United Nations Educational, Scientific
and Cultural Organization

Paris, June 1981

ED-81/WS/68

INTRODUCTION

Every specialism creates, of necessity, its own special terminology. The particular concepts, the ideas relating to them, the special activities associated with the working out of the subject - all these have to be given their linguistic labels so that the workers in the field may communicate meaningfully about their work. This communication can take place with a high degree of precision if the technical terminology is used in a consistent way.

Science and technology education is a specialism and the purpose of this glossary is to promote more complete and precise communication in this field. This communication is of two kinds - between specialists in the field and laymen, and among the specialists themselves. For the first purpose, a number of terms have been included which are commonplace among the educational fraternity, such as "nature study", "pocket calculator" and "project". As to the second purpose, provision has been made for specialists in various ways. For several reasons, but usually those of geography, the developing technical terminology acquires indigenous meanings, while remaining legitimately invented language. Thus "stream table" and other unusual terms will not be understood universally, even among the initiated.

It appears that, in science and technology education, the enterprise of compiling a glossary has not previously been attempted. For Unesco, certainly, this is a pioneering endeavour. It is not therefore expected that all the entries will be found to be universally acceptable. Unesco accordingly invites comments on this draft version and contributions for a more definitive version to be compiled in the future. Please address them to:

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Abstract - 1. refers to a scientific idea or concept, or approach to teaching which is several steps removed from its observable manifestations and thus depends mainly on equations or imaginary representations, thus "The concept of relativity as taught in universities is abstract."

2. a mental process by which the individual generalizes an idea, thus, "The child abstracts his or her concept of an insect from all the things he or she has seen called 'insects'."

3. a short summary of scientific report which may be "descriptive" by telling what it is about, or "substantive" by describing the main ideas and/or conclusions of the report.

Accommodation - taking up a new idea or experience by modifying one's knowledge patterns to make it fit. COMPARE with "Discrepant event". CONTRAST with "Assimilation".

Activity - 1. a form of learning which is usually completed in a single hour or session, and involves the learner in doing something other than reading or listening; it includes things such as measuring, experimenting, building, etc.; it may be done either individually or as a group, it sometimes refers to a component of a unit or a module.

2. <u>any</u> learning action including reading and listening.

Adapt - to modify something to suit a particular situation and then use it. Often applied to a specific science course, curriculum, or approach to preparing these. Sometimes applied to certain pieces of scientific equipment.

Adapting implies that the circumstances of the user are slightly different from those which the originator had assumed.

Adopt - to use something without modification. Is usually applied to a specific course or textbook.

Advance organizer - a general and relatively abstract statement that precedes a segment of learning, and provides a connection between the new learning and the learner's previous knowledge. Acts as a "bridge" to make new learning more meaningful. Sometimes applied to a single word concept which serves the same function. Used mainly in connection with learning theory attributed to D.P. Ausubel.

Affective - applied to a type of educational objective which is conceived to influence the learner's feelings for or about something. SEE "Attitudinal".

Aims - often used interchangeably with 'goals' and 'objectives'. But aims can be both 'broad' and 'narrow'. For the broad sense, SEE 'General objective'; for the narrow, SEE 'Specific objective'.

Air table - a large flat surface perforated with numerous small holes, through which compressed air is forced, so that smooth solid discs or other vehicles will slide across the surface with imperceptible friction. May range in dimensions from 0.5m x 0.5m to 3m x 3m. Used to study the dynamics and kinematics of collisions.

Alphabet soup (colloquial) - refers to any one or all of the science courses and/or programmes developed with grant support from various foundations. Often used to distinguish certain courses from those based on traditional science textbooks. Derived from the tendency to refer to these "new" courses by initials such as: PSSC, ASEP, MACOS. SEE list of acronyms in appendix for the meaning of many in common use.

Analogue - a system which corresponds in some respects to a complex natural system. May be an artificial system or a simpler natural system. Used to explain a complex natural system. SEE "Model".

Analysis - a type of thinking or reasoning activity in which the learner is required to disentangle different aspects of the situation with which he is presented. Examples: to recognize unstated assumptions in an argument; to identify all the variables that might influence a given situation. Often refers to one of the higher levels of cognition.

Apparatus - any piece of equipment or any instrument, home made or commercially produced, that is used in teaching.

Application - the use of an idea, a principle, a technique, etc., in a situation that is new to the learner. Sometimes used to describe a test item that requires the learner to make this use. SEE "Recall".

Appropriate technology - technology which is appropriate to the needs of the community or of the problem under consideration. SEE "Technology".

Aptitude - a characteristic which enables a person to learn some things more easily than other things. Thus, "She has an aptitude for mathematics".

Aptitude test - a test designed to discover if aptitude for some branch of learning is present in a person. SEE "Aptitude".

Assessment - a quantitatively or qualitatively obtained estimate of a particular skill, ability, attitude or achievement, associated with some educational objective or set of objectives. Sometimes refers to a comprehensive test of an individual's achievement. Also used to mean a large scale attempt to measure the knowledge and understanding of a particular group.

Assimilation - absorbing a new idea or experience, and making it part of one's knowledge or present pattern of understanding, followed by adaptation in learning theory ascribed to J. Piaget. CONTRAST "Accommodation".

Assumption - anything taken for granted or without supporting evidence. Generally regarded as important step in science research which may or may not lead to a discovery. Recognition of assumptions is often an objective of teaching scientific inquiry.

Attitudinal - generally used to describe those educational objectives which seek to influence an individual's feelings about what is to be learnt. CONTRAST "Scientific attitude".

Audio-tutorial - SEE "Auto-tutorial".

Audio-visual - refers to communication which uses, particularly, recordings, films, slides etc.

Auto-instruction - SEE "Auto-tutorial".

Auto-tutorial - a way of structuring individualized learning in which learner activities are directed mainly by printed instructions or an audiotape or both. Sometimes involves a variety of learning activities and media, such as films, experiments, videotape, slides, etc. With this technique the learner controls his or her own rate of progress.

Awareness - a state of mind in which the individual knows that a thing, a problem or an idea exists, even though the individual may not fully understand it. For example: "Many city dwellers have a general awareness that air pollution is a growing problem, but do nothing about it". Sometimes regarded as a first level of understanding.

Behavioural objective - a desired educational outcome which will have an influence upon the learner's actions or ability to do something, such as "list", "assemble", "use", "criticize" etc.

Black box (colloquial) - a piece of scientific or technological apparatus that can be used without the user knowing how it works, as, for example, in "A telephone is a black box to most people". Sometimes used to refer to an object in a classroom of which learners are challenged to "infer" the contents by using clues obtained by senses other than vision.

Bread-board - SEE "Circuit board 1".

Calculator - a device for arithmatical computation. Often refers to a small pocket-size, battery-operated instrument which teachers encourage students to use in the interest of economy of time in problem solving. Enables learner to concentrate on the principles involved and avoids learners being penalized for computational errors.

Case history - information about the origins of important ideas and events, such as a specific discovery or decision of some sort. Often presented in "story" form for teaching purposes. Thus, "As a case history, biology students may wish to read about Fleming's discovery of penicillin."

Cassette - a tape recording held within a plastic container into which the tape is rewound. A common component of auto-tutorial programmes. Much used in commercially produced musical recordings.

Child centered curriculum - an approach to teaching, which is determined primarily by the interests, abilities, and previous experience of the child, and only secondarily by the content and structure of what is being taught.

Circuit board - 1. a flat piece of material drilled or otherwise modified to facilitate the mounting and connection of various electrical components such as resistors, coils, batteries, transistors, etc. Used to assemble experimental electronic devices.

2. a flat piece of material with several points for making electrical contact and a hidden network of wires connecting certain pairs of the contact points, used especially in teaching inference to younger learners.

Circus - a technique of arranging a science classroom in which the materials needed for a different activity are provided at each of several stations in the room. Learners work at one station, then another. The sequence is not critical, usually involves 'hands-on learning'. SEE "Hands-on learning".

Classifying - grouping objects into sets of things, using as the criterion some attribute (such as colour or shape) which the objects have. One of the "processes" of science.

Clearing house - 1. a place in which certain educational materials and/or information are stored and made available for use by interested individuals.

2. a place for sifting applications for places in higher education. Facilitates the choices of applicants and the selections of institutions.

Closed-circuit (TV) - the linkage within an institution of TV receivers to a TV camera to permit a lecture or a demonstration or the performing of an experiment to be observed by a wider audience than the one actually present.

Closed question - SEE "convergent question".

Cognitive - refers to the intellectual activity of a person associated with knowing, understanding and reasoning. Often used to distinguish one type of educational objective from another. CONTRAST "Affective", "Psychomotor".

Cognitive preference - an individual's tendency to think about something in a certain way and to prefer that way to other ways of thinking. Thus one person may prefer explanations of scientific principles in which a large number of applications are described, while another person may prefer a detailed analysis of the variables that are related in the same scientific principle.

Cognitive structure - an assumed pattern of inter-relationships of ideas in a person's mind which is likely to influence what he attends to in his environment and how he interprets it. A general framework of thinking that both constrains new learning and is altered by that learning.

Cognitive style - generally, the conditions in which an individual learns most effectively, or which the individual prefers. May refer only to the preferred physical environment for conducting learning tasks. SEE "Cognitive preference".

Combined science(s) - a course, usually taught by one teacher, which includes aspects of biology, chemistry, physics and, perhaps, other sciences with some links between them. CONTRAST "Integrated science".

Competency based - refers to an instructional system in which certain objectives are specified for learners, and the learner progresses to subsequent portions only after these objectives are achieved. Often used in connection with individualized instruction, and in the training of teachers.

Comprehension - understanding a concept or an idea, or an argument to such an extent that the person can express it in his own words. A higher level of understanding than "recall", but lower than "application". SEE "Recall" and "Application".

Computer - an electronic device capable of performing high speed computations. It may also be used as a teaching aid. It is also useful in science for modelling or simulating real situations as a way of predicting the probable effects of changing certain factors in the situation. It is especially useful in modelling experiments beyond the capability of a school science laboratory. SEE "Simulation".

Computer managed instruction - any one of several schemes by which a computer can direct a learner through a sequence of learning activities. May prescribe specific remedial work on the basis of test results.

Computer search - a procedure by which references to books, articles, and other data are sorted out from an extensive collection according to one or more specific criteria, Usually results in a computer giving bibliographic references and often an abstract of each of these. SEE "Printout", "Abstract (3)".

Computer simulated experiment - a process by which a computer provides realistic data in response to the learner's manipulation of independent variables in a simulated situation. For example, a computer can simulate the effect upon a paramecium culture in a nutrient broth of variations of the temperature, nutrient concentration, and incubation time, and can respond with realistic population densities for any combination of these independent variables. This type of "experiment" has been devised for teaching purposes in many of the sciences. SEE "Simulation".

Computer terminal - a typewriter-like device used to send data and other information to a computer. Sometimes associated with a printing device which makes a record of the input and also prints the computer response or output. Used in most computer assisted instruction. Sometimes associated with a visual display. SEE "Computer assisted instruction", and "Interactive computer".

Concept - 1. an abstract idea of a particular attribute held in common by a class of objects or phenomena. The mental awareness that exists for such an attribute. Thus, "Light, heat and sound are manifestations of the concept of energy". Some, such as salt, are concrete concepts, while others, such as energy, are abstract concepts. SEE "Construct".

2. occasionally a statement of great generality in science, as in "The sun is the source of all the earth's energy". SEE "Law", and "Principle".

Concept oriented curriculum - a curriculum in which the principal emphasis and/or objectives are the major concepts or generalizations of science. Often applied to the primary curriculum. CONTRAST "Process oriented curriculum".

Concrete - refers to experience or planned educational activities in which the learners see and/or handle real objects. Also relates to ideas or concepts which correspond to or involve real objects. CONTRAST "Abstract (1)".

Concrete operational thinking - a stage of development in a person's thinking and reasoning ability in which logical thought is possible so long as the ideas and concepts are related directly and obviously to real things. Often regarded as a typical mode of thought for ages 7-11 but probably applies to the acquisition of new knowledge at all ages. Follows the stage of intuitive thought. Precedes formal operational thought. Has been described by psychologists in terms of what individuals can and cannot do in any sphere of learning. Thus, "A person who is at the concrete operational thinking stage does not conserve 'displaced volume', and cannot think easily in terms of two variables changing simultaneously".

Construct - a mental model, image or idea invented to help in explaining a range of phenomena. Thus, "Scientists have used the construct of 'phlogiston' to explain burning", and, Thomas Young first used the construct of 'energy' to explain the capability of some things to do work". Sometimes used interchangeably with "abstract concepts". SEE "Concept".

Consumable materials - SEE "Expendable materials".

Continuing education - activities, courses, or programmes conducted for adults or other individuals who have terminated their formal education. Science courses in these programmes tend to be based on contemporary interest, rather than as part of a degree programme. Such courses usually carry no academic credit. Frequently offered during evenings or weekends.

Continuous assessment - an ongoing and cumulative set of grades achieved on parts of a course of learning. Intended to provide frequent feedback to the learner. SEE "Assessment", "Feedback".

Contract learning - a system for managing individualized learning in which the learner and teacher agree on what the learner will do for a period of one or more weeks. Often formalized by a written statement signed by the two. Often used with advanced learning or special projects for the age group involved.

Controlled experiment - an activity conducted to provide data to answer a question or to test a hypothesis in which only one variable is deliberately changed (independent variable) and the consequences observed in terms of change in other variables (dependent variables). Great care is taken to assure that other independent variables are kept constant (i.e. controlled).

Conventional science - courses in traditional science subjects, and taught by lectures and occasional laboratory or practical sessions. SEE "Separate science" and "Traditional science".

Convergent question - a question asked of an individual or group of learners by a teacher with the expectation of a particular answer, as in, "What is the molecular mass of methane?". Also a question which brings together and summarizes a learning sequence, as in, "What type of clouds are associated with heavy rain?". Also called a "closed question". CONTRAST "Divergent question".

Cooperative education - a programme at either the secondary or tertiary level in which the learner works part-time in a job related to the vocation or position which he or she hopes to enter. Thus, science teachers in training may work part-time as museum guides in a cooperative education programme.

Core - a part of the curriculum which is compulsory for all eligible learners.

Core curriculum - 1. Those courses required of all learners in a given programme.

2. an approach to teaching in which a contemporary problem is investigated in its entirety by a class. Aspects of many areas of learning are incorporated. Thus, the problem of alternative energy sources can be studied and used as a way of teaching science, mathematics, communication skills, history and fine arts. Most often team taught. Learners usually have a part in structuring such work, and therefore the structure of a given unit may be different each time it is taught. SEE "Structure".

Course - 1. an organized study of some topic over an extended period of time. Often not longer than one year. Sometimes restricted to a single subject. SEE "Curriculum", "Module", "Unit".

2. published materials designated to assist the learning of some subject.

Course aim - SEE "General objective".

Criterion referenced test - a test in which the learner's performance is compared to a set of explicit objectives (i.e. criteria). Gives each candidate a "YES" or "NO" answer as to whether his performance fulfils the objectives. Thus the purpose of such tests is not to compare the individual's results to those of other individuals. Used in some individualized science programmes in which the learner must meet the criterion for one unit before going on to the next. Often based on behavioural objectives. CONTRAST "Norm referenced test". SEE "Behavioural objective".

Critical thinking - a mental process in which the individual analyzes a situation, applies appropriate principles, uses relevant facts, and makes a logical deduction or generalization, or asks an important question, the answer to which will clarify the situation.

Culminating experience - the concluding activity of a piece of learning in which the major educational objectives are generalized and related to each other.

Curriculum - 1. the totality of the learning experiences provided by a particular institution, which may be a school or group of schools in a district, state or nation. May include learning acquired other than in planned courses, such as clubs, seminars, etc. COMPARE "Hidden curriculum" and "Extracurricular".

2. all the materials, especially those that are printed, used in a course or programme.

3. a collective statement of what is to be learned in a course or programme.

4. the total physical product of a curriculum study, usually includes several of the preceding.

Curriculum development - a project in which a course or set of instructional materials is designed, developed, field tested, revised and made available on a large scale for adoption. Usually based on a philosophy and other premises that differ from what has previously held sway. Sometimes extended to include ongoing development of curriculum materials as in the case of the Biological Science Curriculum Study (BSCS).

Curriculum materials analysis - 1. a process of systematically and objectively identifying the component parts of a course or set of instructional materials. Thus one system for conducting the process with science materials is based on the components of: content, instructional methods, adaptiveness, effectiveness, and administration.

2. a report of the process, used in comparing various instructional materials and in judging whether stated objectives are likely to be achieved.

Curriculum study - SEE "Curriculum development".

Data - one or more sets of observations collected as part of an experiment and intended to be the basis for drawing a conclusion. Usually obtained and arranged in a systematic way, frequently quantitative.

Data base - the complete collection of information stored in the memory of a computer, or which can be retrieved by a computer. Also (in a broad sense) any index or library.

Day-release courses - education provided usually for young apprentices in industry on the basis of one whole day's study per week, and for which the employer releases them from work.

Debrief - any activity designed to sum up any one of several types of learning activity. Used to generalize results, review what happened, and to identify the most important learnings. May form a connection to the next learning activity. Important in conjunction with open-ended activities such as games especially. SEE "Game", "Open-ended", "Post-lab". A colloquialism coming into wider use.

Decision making - a process for selecting one action from among several alternatives which involve environmental, technological, educational or personal problems. Often cited as a skill to be developed by learners in a science programme or course.

Deductive approach - a learning approach in which the learner first encounters the principle (or generalization) to be learned and then is led to its consequences, to examples of its application, or to data which supports it. Thus Newton's third law might be stated and examples of action-reaction then derived and/or demonstrated. CONTRAST "Inductive approach".

Deductive sequence - a series of learning activities which proceed consequentially from the general to the specific. CONTRAST "Inductive approach".

Defining operationally - a process of science. Involves defining things in terms of physical procedures. Thus, "sand" can be defined as particles or rock which will pass through a screen in which the openings are 2mm in diameter, but will not pass through one in which the openings are .016mm in diameter. Can be used at varying levels of complexity and sophistication. Used in an attempt to avoid ambiguous use of terms. SEE "Operational defintion".

Demonstration - a procedure which involves showing science equipment and/or materials to a class, with, usually, an explanation of purpose and use. Often serves as a dynamic illustration accompanying a lecture or discussion. SEE "Experiment" 2.

Demonstration experiment - a scientific experiment performed, usually, by the teacher as a demonstration. SEE "Demonstration".

Developer - a person or a member of a group of people, who has designed, produced, and field tested a new product for use in education. The product may be an instructional unit, a course, a book, a piece of apparatus, etc.

Development - 1. the process by which an educational product is carried from conception to actual use. Involves design, production and (usually) field testing. May be an ongoing or continuous loop process, as in the case of "curriculum development", where field testing produces results which are used as a basis for improving the product.

2. a series of increasingly sophisticated stages of a concept. So, the concept, "acid" may be attained by a learner through a series of lessons or learning activities, over a period of time, which may range from hours to years.

3. an internal process of organisms in which growth proceeds along lines typical of the organism. As in the mental growth of a child with increasing age, or in the growth of a plant from seedling to maturity.

Didactic teaching - teaching that is based predominantly on telling or on the verbal presentation of knowledge by the teacher. CONTRAST "Heuristic teaching".

Differentiated Science - SEE "Separate science".

Diffusion - a more or less random and usually unsystematic spreading of teaching ideas, practices and materials to other people and places. Sometimes a deliberate effort to do so. SEE "Dissemination".

Discovery learning - learning that results usually from a challenge to find out something. Is also applied to spontaneous learning, where the learner 'sees' something in a new light. SEE "Discovery teaching", "Guided discovery"and "Inquiry".

Discovery method - SEE "Discovery teaching".

Discovery teaching - an inductive procedure for conducting learning activities that encourages the individual learner to experience discovery learning. Usually contrasted to "expository teaching" or"didactic teaching" in which that to be learned is explicitly stated by the teacher. Sometimes any open-ended activity. SEE "Discovery learning".

Discrepant event - an observation which the observer is not able to explain. Something which does not "fit" into previous experience and learned explanation patterns. Often deliberately presented by teachers to initiate inquiry learning, or to motivate students in didactic instruction. SEE "Inquiry" and "Didactic teaching".

Dissemination - a deliberate attempt to spread new educational practice or ideas and skill in using them to other people and places. May be accomplished by such means as articles in professional journals, in lectures, in workshops or at conferences. Includes commercially sponsored advertising.

Divergent question - a question directed to an individual or a group of learners which seeks a response that goes beyond recent learning and is not pre-conceived by the teacher, as in "What consequences does the Second Law of Thermodynamics have for efforts to find alternative sources of electricity?". Often results in unexpected responses. Also called an "open question". CONTRAST "Convergent question".

Dry lab - 1. a classroom activity in which the pupils are given experimental data to process and interpret. May include drawing graphs, making inferences suggesting further experiments. Although 'dry labs' may begin with some practical activity to get a qualitative feel of the phenomenon under investigation, the full process of data gathering is omitted on grounds of difficulty, cost, or time, or with the desire to introduce more accurate data from research publications.

2. efforts by some students to complete a laboratory report by using reasonable (but fictional) data that will support a preconceived conclusion. Sometimes called a "cooked experiment".

3. a laboratory with no gas, water or drains.

Dynamics cart - a small three- or four-wheeled vehicle, fitted with roller-skate or other low friction wheels, and a spring-loaded plunger which moves into the body of the cart upon impact with another object. Used in studying the dynamics of collisions.

Dynamics trolley - See "Dynamics cart".

Earth science - the study of the earth; SEE "Geology".

Elective - 1. a course which is not compulsory for all eligible learners, but which a given learner may choose as part of his programme of studies. Sometimes refers to a course that deals with a new or related aspect of a major field of study. Thus a course in "exogeology" (a study of the physical composition and processes of planets other than the earth) might be 'an elective' for a student working toward a degree in geology.

2. an alternative activity within a course, which the learner may or may not choose to do. An optional activity.

Empirical - refers to evidence, generalizations or practices which are based purely on experience, experiment or observation, often without any supporting basis in scientific theory. Thus, if a mechanical concrete mixer stops working, an 'empirical' practice (to keep the concrete from hardening) is to add several cups of sugar.

Empiricism - a philosophical procedure which emphasizes the generation of scientific knowledge by starting with direct observation of and experimentation with real things.

Enactive representation - describes knowledge gained from interaction with, and/or manipulation of tangible objects. For example, knowing by feel how a see-saw works, and being able to balance it.

Energy - the capacity of an object, or a source, or a condition to do 'work'. With an object, it may be manifest in the movement of the object or in its position in space. Sources of energy include emissions of light, heat, wave motion etc. Molecular structure is a common condition which implies the presence of energy. SEE "Work".

Enquiry - SEE "Inquiry".

Enrichment - a learning activity that is supplemental to all the activities that form the body of a course, or unit of study. Often reserved for the more capable, or more highly motivated learners in a class as an option to be exercised after the regular activities have been completed.

Environmental education - 1. an approach to learning which takes as its starting point the environment of the learner, drawing upon his/her partial knowledge or observations of it, and elaborating these into a fuller, deeper knowledge. Uses the learner's surroundings to emphasize the relevance of what is learnt in school to life outside it.

2. learning which emphasizes the problems and concerns of maintaining desirable surroundings and circumstances for living things, especially humans. May include aspects of science, mathematics, social studies, humanities and arts. Usually involves learning activities both outside and inside the classroom.

Environmental science - a form of environmental education designed specifically to give scientific insights, knowledge of science and motivation for learning science. SEE "Environmental education 1".

Epistemology - any theory or system purporting to explain the nature of, growth of and conditions for knowledge. An important acquiring component of educational research, as epistemological discovery can and does profoundly affect educational practice.

Equipment - the more or less durable things which are not consumed or used up in the business of teaching. Usually refers to laboratory or audiovisual instruments which have an expected lifetime of many years. Differentiated from "materials" which usually require frequent replacement, although things such as test tubes are difficult to classify as one or the other (in the USA, anything to be used in a science class which costs more than $25). SEE "Materials".

Evaluation - 1. a process of obtaining and summarizing information about the effectiveness of a course, teaching method, instructional activity, or any other variable in education.

2. a process in which the information on the effectiveness of one or more of those variables is compared to a set of criteria which represent value judgements of what is desirable. Often applied to the attainment of individual learners in a course, or in some part of the course as, for example, in laboratory work.

Evidence - those observations and empirical data gathered and used to test the acceptability of a hypothesis, conclusion, or answer to a question. Often restricted to those observations and data that support a specific hypothesis, conclusion or answer.

Excursion - a relatively short journey outside the usual school boundaries made to see a place or thing usually for specific educational purposes. Usually a group of learners and a teacher is involved, but sometimes only individuals. SEE "Field trip".

Expendable materials - things that are perforce used up in education such as candles, matches, filter paper, chemicals, workbooks, etc. Things that must be purchased prior to a teaching sequence. Sometimes called "expendables" or "consumables".

Experiment - 1. a procedure in which data is acquired by observation in some methodical way in order to provide an answer to a question or to test an hypothesis. Usually involves the manipulation of some apparatus, especially to measure one or more variables. Often designates a procedure in which only one variable changes, and the consequence in terms of another variable is observed. Often restricted to those procedures in which the results are not known in advance to either the learner or teacher. Sometimes, especially in science teaching, refers to any activity in which the learner manipulates apparatus or other materials to get a result known in advance to the teacher.

2. classroom demonstrations conducted by the teacher, or by one or a small group of students for the whole class.

Extra-curricular activities - activities associated with schools, but which take place outside of the usual schedule of classes, and which are optional for learners. Includes meetings of the science club, project work, science fairs, school societies, singing, dancing, acting, making music, etc.

Extrapolation - the reckoning of a measure indirectly by reference to a series of measures already made, but which follow or precede the required measure. SEE "Interpolation", "Predicting".

Fact - a statement of appearance or relationship based on direct observation which is generally accepted by the scientific community. Not likely to change significantly in the future. May be the mean or average of a large number of observations or measurements. Thus, "It's a fact that the mean distance of the sun from the earth is 150 million kilometres".

Feedback - 1. information about the effectiveness of a teaching system or approach which is used specifically to modify the system or approach to gain greater effectiveness. May be "formal" in the form of test results, or "informal" in the form of spontaneous observations and conversations.

2. information about the state or condition of any controlled system which is analyzed, and appropriate action initiated to cause the system to achieve or to maintain a given state or condition. May occur within an organism or a machine such as a computer.

Field study - a learning activity in which observations and data are derived from natural areas out of doors, as opposed to controlled laboratory situations. Often based on open-ended inquiry. SEE "Inquiry" and "Open-ended".

Field studies centre - a location in rural or remote area from which school groups can study various aspects of nature or undertake field study. SEE "Field study" and "Land laboratory".

Field-test - a process by which a prototype educational product (such as an instructional unit, course or piece of teaching apparatus) is tried with real learners before the product is made available to the education community at large. Usually provides feedback for final revision or for modification of the product. SEE "Feedback", "Trial".

Field trip - a journey made away from school to see a place or thing for educational purposes. May last from an hour to several days. SEE "Excursion".

Film loop - an instructional device that contains a single event or related series of events on film of about three minutes running time. Often packaged in self-rewinding cartridge which requires a special projector. Widely used in individualized science instruction. Frequently illustrates phenomena such as the opening of a flower or the impact of a moving car and a brick wall by the process of speeding up or slowing down the movements involved.

First generation- sometimes used to refer to the first wave of "new" curriculum projects developed in the late 1950's and early 1960's. Also refers to those teachers who taught the experimental versions of those courses. SEE "Second generation".

Formal operational reasoning - a stage of human development in which the learner is able to make mental use of previously abstracted relationships or concepts. Individuals at this stage are also capable of visualizing abstract models, making mental use and asking questions about them. Also implies ability to predict the effect of changing two and possibly more variables in a given situation. SEE "Concrete reasoning".

Formative evaluation - a study of the effectiveness of parts of a unit or of a course or of instructional materials during use in the classroom, and undertaken with a view to making an improvement.

Game - a package of learning material for informal learning situations which may require special equipment such as a board or computer. Designed for specific educational purposes. May involve rôle play. SEE "Gaming".

Gaming - a type of activity in which two or more learners (i.e. players) follow a set of arbitrary rules which result in one person (or group) becoming the winner. Educational objectives may include factual knowledge, attitudinal change, skill development or some combination of all of these. Learning interactions may involve person-person or person-machine (i.e. computers, game board, etc.) types. SEE "Stimulation".

Generalizing experience - an activity conducted at the end of a learning sequence and intended to summarize and emphasize the objectives of the sequence. Most often organized as a group rather than an individual activity.

General objective - of following a course of study. An outcome that is hoped for as a result. A statement of something that is to be achieved in a (science) unit or course in terms such as "appreciate" and "understand" which are not directly observable, sometimes called "a broad aim". CONTRAST "Behavioural objective", "Specific objective".

General science - a course usually taught by one teacher which includes aspects of biology, chemistry, earth science and often other sciences with occasional links between them. May be intended as an introduction to the separate sciences.

Geology - the study of the earth's crust, including the flora and fauna which have, in the past, dotted and inhabited the earth's surface. COMPARE "Earth Science".

Goal - 1. often used loosely to carry the same meaning as a specific objective. SEE "Specific objective".

2. a long range educational outcome of greater generality than a specific objective, but more precise than a broad aim. Often applied to a particular subject of the curriculum. So that a common goal in mathematics is to inculcate an ability to think logically. SEE "Aims".

Grade - 1. a stage of one year's duration on the educational ladder of a school.

2. an assessment or teacher evaluation of a piece of a learners work. Often given in the form of a letter, A, A-, B+, C, etc. in order of decending quality with E or F often designating failure. Sometimes the grade is simply "pass" or "fail" with no effort to differentiate quality levels any more precisely.

Groups - 1. a number of learners forming a part of a class with a common and immediate educational interest and objective, as in the case of a group making a report on the hazards of radioactivity. Often assigned by the teacher to promote cooperative learning.

2. a number of learners separated from others on the basis of interest and/or ability, as in the case of those who are recognized as having high intelligence or low reading ability. Usually formed for instructional purposes in the belief that doing so maximizes learning. SEE "Heterogeneous", "Homogeneous".

3. in mathematics, the study of sets of objects having the well-defined structure of 'a group'.

Group work - any learning activity in which a number of learners collaborate in achieving a specific task, as in the case of analyzing the vitamin C content of various fruit juices, followed by a pooling of results.

Growth chamber - a piece of laboratory equipment in which living organisms can be maintained in a controlled environment. Facilitates the control of variables such as temperature, light and humidity. Most often used with multicelled plants and animals although occasionally used with micro-organisms.

Guided discovery - an inductive procedure for promoting learning in which learners are expected to learn a specific thing, although the latter is never explicitly stated by the teacher. Should be compared to "discovery learning" in which that which is learned is not specified in advance. SEE "Discovery learning".

Guide-sheet - a set of printed directions for learners to follow in conducting laboratory exercises or other learning activities, often provides space for the learner to write observations, conclusions, etc. which are subsequently submitted to the teacher. SEE "Worksheet".

Hands-On-learning (colloquial) - any learning activity in which the learner manipulates or handles objects, equipment, or material. Distinguished from vicarious activity in which the material is just described, or is handled only by the teacher.

Hardware - a generic term for the instruments and equipment used in teaching and learning. Especially associated with audio/visual aids. Excludes printed material. May include things such as projectors, laboratory balances, galvanometers, animal cages, etc.

Heterogenous group - refers to classes of either mixed ability, interest, prior achievement, age, gender, or any combination of two or more of these or other characteristics. Often a random selection from the total school population of a given age or grade level.

Heuristic teaching - planned learning and/or teaching in which the learners are encouraged and provoked to find things out for themselves. SEE "Discovery learning". CONTRAST "Didactic teaching".

Holistic approach - an approach to developing curricula or planning learning activities in which the boundaries between traditional school subjects are largely ignored, for example, as in the holistic approach to health, in which the chemical treatment of disease, preventive medicine, and psychological nutrition, etc. are combined, for instructional purposes, in a single course.

Homogeneous group - a group of learners that has been separated from others on the basis of some quality or set of qualities such as sex, parental income, previous academic success, intelligence, career plans, etc. CONTRAST "Heterogeneous group".

Hypothesis - a testable statement of a seemingly reasonable or likely relationship or explanation. As in "capillary action is the process by which water rises in trees". Used as a starting point for most scientific investigations.

Hypothetico-deductive - a description of an investigation which begins with hypothesis, follows with the deduction of observable consequences from the hypothesis, ends by comparing what has been deducted with what is actually observed.

Implementation - putting an educational plan or idea into effect. Sometimes refers to installation of a particular course, and may include special training for teachers.

Independent study - a series of learning activities planned cooperatively by a teacher and a learner in which the latter works for most of the time on his/her own. Often includes several conferences with the teacher during the study. Usually terminated by a paper or detailed report, or sometimes by a test. SEE "Post-test".

Individualized instruction - a form of classwork in which tasks are given to the learners on the basis of their capacity, their interest, their previous attainment and similar individual characteristics. Sometimes refers to activities in which the learner's only choice is rate of learning. Sometimes refers to a programme of studies which is unique to the learner. COMPARE "Independent study".

Individual investigation - a study which involves a considerable amount of data being gathered from the field, the laboratory, and/or the library, and which is based on a question or hypothesis which is unique to a given learner. Ordinarily the investigation has no preconceived outcome. SEE "Open-ended".

Induction - 1. the formulation of general laws by observation of many instances.

2. the gradual introduction of a novice to a specific job.

Inductive approach - an approach to learning in which the principle or the generalization to be learned is led up to by first encountering the evidence and the thought processes that support the principle or generalization. The learners may, for example, be given many particular examples, and asked to discern the general pattern. CONTRAST "Deductive approach".

Inference - a conclusion or plausible idea based on the interpretation of something actually observed. Some people have difficulty distinguishing from an observation, as in "One possible inference based on observing wet pavement is that it rained recently".

Inferring - one of the processes of science in which the individual makes inferences and distinguishes them from observations. SEE "Inference", "Process of science".

Informal education - education that is received other than through official channels. Examples include, reading, conversations with other people, listening to radio broadcasts etc.

Innovation - a new practice in teaching, such as a new course, a new way to conduct laboratory, or a new way to teach as in "computer simulated experiments are an innovation in science teaching".

Instrument - 1. a mechanical device for making some type of detailed observation and/or measurement such as a microscope, calipers, timer, balance, spectrometer, or respirometer.

2. written or printed material intended to obtain information as in a test, questionnaire, or survey form.

Inquiry - an approach to learning in which a learner or group of learners search for an explanation of a problem. May be limited to reading 'to find out', but often involves the collection of empirical data. Usually based on a question or problem which does <u>not</u> have a single simple answer. COMPARE with "Discovery learning".

Inquiry development approach - a teaching strategy intended to develop learners' skills in logical thought, questioning, and creativity. Usually involves the sequence of a teacher demonstrating something interesting and unknown to learners (i.e. a discrepant event), who then ask questions that can be answered "yes" or "no". Questioning continues until learners are satisfied with the explanation they have developed. SEE "Discrepant event", "Teaching strategy".

Inquiry training - any procedure in which individuals develop skill in asking scientifically meaningful questions. Often done by having individuals respond to a provocative demonstration by asking the teacher questions which can be answered only by "yes", "no" or "maybe".

Integrated science education - 1. those science courses devised and presented in such a way that learners gain the concept of the fundamental unity of science, and are helped to gain an understanding of the role and function of science in their everyday lives and the world in which they live.

2. those science units or courses in which elements of non-science subjects such as art or history are combined appropriately with those of science.

3. some science units or courses which are organized around a theme which involves the use of more than one of the disciplines of science.

Interactive computer - a computer so arranged that a learner may respond to questions from the computer, or put in data, followed by an immediate response by the computer. Many repetitions of this cycle. Used in most computer-assisted instruction procedures. Distinguished from a batch process computer, where responses are printed out in some remote location and obtained by the learner at daily intervals. SEE "Computer assisted instruction".

Interdisciplinary science - an approach to curriculum design in which one of the separate sciences (e.g. chemistry) is linked to another separate science in each of several component units. Also refers to an approach in which certain problems, often dealing with the environment, are treated from the perspective of several special sciences.

Interface - refers to the boundary, real or imagined, which lies between two disciplines of study, as, for example, "the interface between history and mathematics". Is given special attention by those who are concerned to present knowledge as a unity, rather than a diversity of 'subjects'.

Interpolation - the reckoning of a measure indirectly, by reference to measures made below and above the measure required. SEE "Extrapolation", "Predicting".

Investigation - an extended inquiry by individuals (or by a group) which may involve experiment, reading, fieldwork, etc. Also, any extended effort to find an answer to a question, or to test an hypothesis using one or more processes of science. SEE "Inquiry", "Process of science", "Individual investigation".

Invitation to inquiry - a learning activity in which the teacher describes an experimental situation and learners are asked to analyze, comment on or criticize the process aspects of the situation. Often used in a series of increasing complexity. Often categorized by a "topic", which is the

process-based objective of the activity, and by a "subject" which is the content used. Thus the topic of "sampling problems" may be treated through the subject context of "population growth", and, similarly, "interpreting complex data" through "plant physiology". SEE "Process of science".

Keller plan - an application of individualized instruction in which the learner is evaluated by an instructor at the end of each completed unit. A time schedule is usually set in terms of a monthly calendar, but it does not prescribe the hours of effort for the learner.

Kit - a package of materials and/or equipment which enables a teacher to conduct a learning activity or a group of related activities with one or more learners. Usually contains sufficient material for a class. Usually assembled and sold by a commercial supplier.

Laboratory - 1. an area devoted to making systematic observations of phenomena under controlled conditions. A place for conducting any learning activity that involves making careful observations, especially those that involve measurement.

2. a period of time devoted to laboratory or practical work.

Laboratory aide - a person who helps in managing and maintaining a laboratory and the learning activities that occur there. May be an advanced student working on a part-time basis, or an adult who is not certified or licensed as a regular teacher.

Laboratory assistant - SEE "Laboratory aide".

Laboratory manual - a printed guide to learning activities that take place in a laboratory. Sometimes a separate, but correlated book that complements the textbook for a given science course.

Land laboratory - a natural area, usually near a school, which is used to teach certain aspects of botany, zoology, ecology, geology, etc. SEE "Field studies centre".

Law - a generalized statement of a well-established and accepted relationship in science. Sometimes synonymous with "principle". Often a generalization of experimental observations, as in Kepler's Second Law: "The radius vector of each planet passes over equal areas in equal intervals of time." Also used in a definitional sense, as in Newton's First Law which defines "force" in an objective way. SEE "Principle".

Learning activity package - a collection of learning activities assembled to help a learner achieve specific objectives of a given unit of study. Includes a pre-test, used by individual learners who choose to do some or all of the activities, depending on what the learner thinks is necessary to pass the post-test. Often corresponds to a unit in a science course. Frequently abbreviated as "LAP". SEE "Pre-test", and "Post-test".

Lecture-demonstration - a mode of teaching in which the teacher's lecture is interspersed with illustrative displays and/or the manipulation of equipment to illustrate the main points of the lecture.

Life science - an area of science teaching and learning that includes all the sciences that deal with living things and is therefore broader than the traditional biology.

Likert scale - a multiple choice response scale used to elicit information about a learner's attitude to certain statements. As when the four possible responses: "a. strongly agree, b. agree mildly, c. disagree mildly, and d. disagree strongly" are given as replies to "More effort and resources should be devoted to developing nuclear energy". Especially useful in science education in determining attitudes to science and scientific attitudes.

Mastery learning - a system of study in which the science information, the laboratory or process skills to be learned are specified in such a way as to be separately testable by criterion referenced tests. Intended to boost the confidence of learners as they successively achieve each of the component objectives. Often used with individualized instruction. Usually based on behavioural objectives. SEE "Behavioural objectives", "Criterion referenced test".

Materials - printed and other relative inexpensive things used in teaching. Usually includes expendable items. Sometimes includes some minor durable items.

Media - 1. a commonly shortened plural form of 'medium of communication'. Includes things such as films, video tapes, audiotapes, slides, models, etc.

2. material on which various life forms are cultured or grown.

Memory - the power to retain in the mind what has been learnt.

Microprojector - an optical device used to form a greatly enlarged image on a screen. Most often used with specimens and objects that are ordinarily viewed in a microscope. Enables a whole class to see the same thing at the same time.

Mini-course - an organized study of a topic that is intermediate in length between a course and a unit. Usually it is self-contained and not part of a fixed sequence. Sometimes used to mean the same as "unit".

Minigenerator - an encapsulated source of short, half-life radioactive isotopes for instructional purposes. Used by flowing water through the capsule, which dissolves the desired "daughter" isotopes from the "parent" which is not soluble.

Mobile laboratory - a portable table (with drawers) containing apparatus. Usually on wheels. Often contains a sink, a supply of water, and a gas burner. Intended for use in classrooms that were not designed for conducting science activities.

Model - 1. a representation of something in nature that has been devised to help in thinking about it. May take the form of a physical structure or a mathematical equation or a set of equations. Acts as if it were the real thing it represents. Is not a literal image of the thing represented, although it is sometimes mistakenly thought to be. Thus, "A ball-and-stick model may represent the spatial relationships and bonding of atoms in a given molecule". Sometimes two different models will be used for the same phenomenon, as in the case of waves and particles as models for light.

2. an object built to resemble the real thing. May be smaller (i.e. scaled down) than the original as a model of an airplane. May be larger (i.e. scaled up) than the real thing as a plastic model of a leaf. May be life size, as in the case of a plastic replica of a human skeleton. Useful to teach about things that are too large or too small or too rare to be usable with most class groups.

3. a prototype plan or idealized approach to some aspect of education. Serves as a pattern to be duplicated or implemented, as "The Rochester project in science curriculum development follows the FUSE model".

Mode of learning - any one of several distinctive teacher-planned interactions between a learner and some material intended to promote learning. Many such modes exist, including reading, experimentation, programmed instruction, lecture-demonstration, etc. Differs from "teaching method" in that the emphasis is on what the learner does rather than on what the teacher does.

Module - a relatively short amount of organized learning activity. Ordinarily it can be sequenced with other modules in variable order to form a course or a minicourse. Sometimes means the same thing as "unit". Sometimes inserted in a traditional course as a way of updating the course.

Multidisciplinary science - SEE "Integrated", "Unified science", "Interdisciplinary science".

Multiple choice item - a question in a test to which several possible answers are given, one of which must be chosen by the person being tested. Sometimes recommended for testing because it yields objective results and minimizes the subjectivity of teacher evaluation of other types of test items. Sometimes opposed on the basis that higher levels of science thought such as analysis and synthesis cannot be adequately tested by this type. A method of testing which can conveniently be mechanised, and is cheaper to administer than tests which involve written response.

Nature of knowledge - SEE "Epistemology".

Natural Science - a collective term for those sciences that deal with the natural world. Usually excludes those social sciences that deal with human behaviour such as psychology and sociology. Sometimes limited to those sciences grouped under biology, chemistry, physics and geology or earth science.

Nature study - the observation of plants, animals, and other phenomena in non-laboratory setting. Usually descriptive and relatively non-technical. Often regarded as a primitive stage of science. Sometimes advocated as appropriate science for young children. In many countries, the title for science programme in lower grades.

Needs study - 1. an investigation of what learners know and/or are able to do in comparison to an arbitrary list of specific knowledge and skills of which they should be capable. Often precedes the design and development of new instructional materials or the implementation of newly published courses. May be conducted on a local, national or regional scale. Sometimes applied to teachers in terms of their teaching competencies and background knowledge.

2. a curriculum development procedure designed to identify students' present and future anticipated interests in science.

Non-formal education - education that is deliberately provided through official channels, but which does not form part of the official system whereby children and young people are brought to various educational levels in schools and colleges. Examples include adult literacy classes, and the training given by agricultural extension workers. CONTRAST "Informal Education".

Non-science major - a learner at secondary or higher level who is not specializing in science or engineering, but who is enrolled in a science course to fulfil a requirement, or on an elective basis. Sometimes called a "non-science student".

Normal science - one view of science in which scientific research is conducted during periods of relatively settled agreement on an established matrix of theoretical thought that guides the formulation of problems and methods used to investigate them. A condition of science which is often likened to the process of filling in unknown spaces on a well-established outline map of a new continent. CONTRAST "Revolutionary science". SEE "Paradigm".

Norm referenced test - a test in which the individual's performance is compared to that of a rather large group of other, but similar individuals. Often, the comparison group (members of which will have already taken the same test earlier) is of the same age, or is similar in socio-economic background. Sometimes the comparison group comprises all candidates taking the test at approximately the same time. CONTRAST "Criterion referenced test".

Objective - 1. a statement of something that is to be achieved during a unit or course. Usually expressed in learner terms, and describes what should be learned. As in "learners will gain skill in using a microscope". Sometimes expressed in teacher terms, and describes what the teacher will do for learners. As "this unit will give learners a chance to study non-flowering plants". SEE "Goals", "Behavioural objectives", "General objectives", "Specific objectives".

2. refers to observations, etc. which are free from personal bias and interpretation (i.e. not subjective).

Observation - a report of something or some phenomenon which is limited to descriptions of those things actually perceived (e.g. seen, heard, etc.) and/or measured. Specifically avoids any interpretation by the person making the report. CONTRAST "Inference".

Observing - a process of science in which observations are made in varying degrees of precision and accuracy. Includes skill in using various instruments such as a microscope or a PH meter.

Open ended - 1. a type of learning activity in which the end result is not pre-conceived by the teacher or the learner. Usually refers to a certain type of experiment or inquiry. Often leads to further activities or experiment. Often the learner is guided by his own interests.

2. a type of study undertaken with no specific educational objectives to be achieved. Initiated with the assumption that there will be no restrictions to a particular discipline.

Operational definition - 1. identification of something by describing what one does and observes what makes it unique. As, "Oxygen is a gas that causes a glowing splint to burst into flame".

2. an identification based on a description of location relative to other recognizable things. As, "A petiole is a stem-like portion of certain leaves, which connects an actual stem to a leaf".

Organizing theme - a basic idea that underlies and/or unifies the subject matter of an instructional unit. May either summarize or interpret the material. Types include: a process of science, a concept, or a problem at the interface of science and society, as in "inferring", "equilibrium", or "water pollution". Usually distinguished from "subject" and "topic".

Package - a collection of all, or nearly all of the things needed to teach a science unit or course. Includes some or all of the following: print material, learner guidesheets, filmstrips, laboratory equipment, texts, teacher guides, etc.

Paradigm - any one of several conceptual frameworks that guide the research methods, and the interpretations of research results, in science and in science education. SEE "Normal science", "Revolutionary science".

Performance objectives - SEE "Behavioural objectives".

Phenomenon - any naturally occuring event or happening such as lightning, plants flowering, ocean waves, wind, ripening fruit, etc.

Physical science - a generic term that includes any of the sciences that seek to understand energy and non-living matter. Sometimes a label for science courses that contain subject matter drawn from a mix of two or more of physics, chemistry, astronomy, geology.

Pilot - a first and tentative classroom trial of instructional materials, or a new organizational structure for learning. Usually provides 'feedback', on which modifications are based before the broad implementation of the materials or structure occurs. Often called 'a pilot trial'. SEE "Feedback".

Pocket calculator - an electronic device small enough to go into a pocket, and used for a variety of computations.

Polytechnic education - 1. a programme in which learners specialize in industrial arts, applied sciences, and/or technology, usually at the secondary or tertiary level. Ordinarily the main programme offered at special schools or colleges devoted to this aspect of science education. Sometimes includes wide experience in, and understanding of methods of industrial and agricultural production.

2. any form of education received at an institute called 'a polytechnic'.

Post-lab - refers to an activity designed to review and generalize the outcomes and/or what was learned in a previous laboratory activity. SEE "Pre-lab", "Debrief".

Post-test - a test, usually given to a learner on completion of a unit of independent study. SEE "Independent study".

Practical - refers to an a activity, an examination, etc. which involves handling apparatus and/or materials such as a weighing balance or a preserved specimen. Thus, what is called a "practical exam" in one country might be called a "laboratory exam" in another.

Practical class - a class organized to train learners in the proper use of apparatus or in other procedures, involving specimens and materials peculiar to science and technology. Sometimes synonymous with "laboratory class".

Predicting - a process of science. Involves forecasting what will happen in a given situation, depending on relationships that have been established in the past. Distinguished from "guessing". Usually based on interpolation or extrapolation of previous data.

Pre-lab - refers to an activity designed to prepare learners to conduct a forthcoming laboratory activity as effectively as possible. May consist of advice on what to do and what not to do. May include a teacher demonstration of the equipment to be used. May also include a discussion of experimental design and possible techniques. SEE "Post-lab".

Preparation room - a space in which materials, equipment, specimens, etc. are made ready for instructional use. Often adjoins a classroom or a laboratory. Sometimes managed by a laboratory aide or assistant.

Pre-test - a test designed to assess the readiness of a learner to undertake a new sequence of study. Involves a test of the 'prerequisite' knowledge the learner must have before he starts something new. CONTRAST "Post-test".

Principle - a statement of a well established relationship in science. Often involves a key concept or construct, as in "The total energy in a closed system is a constant". Used as an integral part of a larger theoretical framework. May be more subject to change or modification than is a law. Sometimes used to mean the same thing as "law". SEE "Concept", "Construct", "Law".

Printout - the permanent record produced by a computer as the final product of a computation, a computer search, etc. SEE "Computer search".

Problem oriented curriculum - a series of instructional units, each of which is based on a specific problem rather than a topic. Often deals with problems at the interface of science and society, such as "disposing of wastes" or "finding a reliable energy source". May deal with theoretically oriented problems, such as "How can small molecules join to form large molecules?".

Programme (program) - 1. a prescribed group of courses usually leading to a particular degree.

2. all of the ongoing activities conducted by a department, or by an organization such as a teachers' association or a research institute. Activities are related to the overall purpose or mission of the group. May include curriculum development, in-service workshops, lectures, film production, special projects, etc.

3. a set of instructions which can be fed into a computer.

Programmed instruction - a mode of teaching in which the material to be learned is divided into small segments or "frames", which are presented to the learner in sequence, and which usually require a response from the learner before the next segment or frame is presented. Utilizes some device which will inform learner of the "correct" response after each frame, so that the learner can compare his/her response with the "correct" response. Often utilized with an interactive computer, but may be in book form. SEE "Interactive computer".

Project - an extended effort to produce an answer to a question, or to a set of related questions, or to produce a solution or solutions to a relative complex problem. Often refers to that activity of a learner or of a group of learners which results in some type of display or exhibition. Sometimes refers to an effort to produce new learning materials, as a contribution to curriculum development. Sometimes used as a label to distinguish new instructional materials from traditional materials, as in "project materials usually place more emphasis on learners having hands-on experience". SEE "Curriculum study".

Projectual - any material intended to be projected by an overhead projector. May consist of something as simple as a drawing, or a list of words on a sheet of acetate. May be as complex as a model made of transparent material, or a container for chemical reactions.

Psychomotor - refers to specific manipulative skills, in contrast to intellectual skills. Frequently refers specifically to particular educational objectives, as "the objective of this lesson is to learn how to use a microscope to measure small distances".

Radioactivity - the name given to the phenomenon whereby certain atoms spontaneously change into other atoms, and which in so doing, emit electrons, and/or protons and/or neutrons, and energy.

Rationale - an underlying system of purposes and assumptions. Usually prefaces a course, unit, or minicourse. Often related to the general goals of education and addressed to both teacher and learner.

Realia - actual objects which are studied in science. Usually refers to the objects being brought into the classroom. The word distinguishes these objects from representations of them such as pictures, drawings, etc. Examples include leaves, a hamster, a cow eye, a fossil, a thermostat, etc.

Recall - the act of remembering something learnt. CONTRAST "Application".

Recitation - a period of class time in which the teacher leads a learner-based discussion of a recently studied topic, or in which the teacher asks questions for learners to answer. Sometimes distinguished from lecture and laboratory sessions in a time schedule for a course. SEE "Tutorial", "Science seminar".

Relativity - that branch of science which asserts that the observations made by one observer of another depend upon the relative motions of the observer and the observed. So that the observer's view of the situation of the observed is not the same as the observer's view of his own situation.

Relevance - a characteristic of certain subject matter or of certain activities or, indeed, of anything which has a bearing upon the current focus of interest or of investigation.

Reliability - a quality of observations and/or measured data which reflects the confidence that, if the observation or measurement were repeated, the same or nearly the same result would be obtained. A necessary characteristic of "good" data, or of good observations in science.

Required science - science courses or units which are a necessary part of a particular science programme. Distinguished from "elective science" or "optional science", which designate courses that learners may or may not choose.

Research - scientific inquiry or investigation. Often applied to learners' efforts to generate knowledge at their level of sophistication, and that is new to them, using scientific method.

Resource unit - a collection of learning materials related to a specific topic or theme which includes objectives, learning activities, tests, etc. from which a teacher may select for use with a particular class. Contains more than would be used with any one group of learners.

Revolutionary science - one view of science, in which an unsettled historical period of scientific inquiry is characterized by dissatisfaction with existing theoretical frameworks (i.e. paradigms), the invention of new ones, and shifts of allegiance, among members of the scientific community, to their dominant theoretical assumptions. CONTRAST "Normal science". SEE "Paradigm".

Ripple tank - a flat transparent bottomed basin which can contain water to a depth of several centimetres. Usually equipped with a device to generate periodic waves in the water, and a strong light, so that images of the waves projected on a ceiling, screen or table can be studied.

Role play - a mode of learning by simulation in which a human problem is dramatized by learners acting the parts of people involved in the situation. Each "actor" tries to project an assigned point of view, even though he may disagree with it. Usually terminated at some arbitrary point and then discussed by the "actors" themselves. Often deals with problems at the interface of science and society, such as "Should radioactive waste materials be buried in the deep ocean floor?", and played as if it were being discussed in political context such as in a United Nations General Assembly. SEE "Simulation".

Sandwich courses - the formal provision of education associated with work. Usually periods of study which alternate with periods of work, and often periods of one year's duration.

Science adviser - SEE "Science consultant".

Science club - an organization of learners in a school dedicated to furthering the members' individual interests in science. Often meets outside of regular school hours. Often involves activities such as making field trips (excursions), inviting speakers, and undertaking special projects.

Science congress - 1. a meeting of professional scientists or of science educators, during which contributions and discussion are focused upon some particular area of science or aspect of science education.

2. a meeting at which learners read papers based on their own investigations. Reports are often discussed by peers. Sometimes reports are criticised by professional scientists.

Science consultant - 1. a person who provides expert advice on science education projects, such as curriculum development and teacher in-service training. Often affiliated with an institution other than the one doing the project.

2. a person who provides assistance to science teachers in a given school or school district. Sometimes has resources of books and other materials available for loan to teachers. May be a licensed teacher, though not presently teaching. SEE "Science supervisor", "Science co-ordinator", "Science inspector".

Science day - an exhibit similar to a science fair, except that displays are set up for only one day, and competitive ratings are either non-existent or minimized in importance. SEE "Science fair".

Science discipline - an area of study and research which has developed and acquired a set of professional practitioners, journals, associations, and research methods. Usually represented by a university department as botany, inorganic chemistry, geophysics, etc. Sometimes refers to larger and more general areas of study such as biology, chemistry and physics. SEE "Separate science".

Science education - 1. that broad field of education which aims to develop perceptions of science.

2. that area of educational endeavour aimed at preparing teachers of science, and/or of conducting research in the teaching of science.

Science education centre - a place which makes a large number of science instructional materials and equipment available for teacher's inspection. May also loan books and materials to teachers. Enables teachers to become aware of new materials and equipment. Sometimes serves as a location for advanced courses, and for workshops on science teaching. Is occasionally the focal point for a curriculum development project.

Science educator - 1. a professional person who specializes in preparing teachers of science and/or who does research in the process and materials of science teaching.

2. any person involved in teaching science.

Science facilitator - a person who has responsibility for helping science teachers with their teaching, or who is involved in curriculum development, implementing changes, etc. Usually does not actually teach, but provides resources and consultation. SEE "Science supervisor", "Science co-ordinator".

Science fair - an exhibit of displays based on learner projects and/or investigations. Usually judged by scientists and/or science teachers. Often competitive, as displays are rated or categorized on the basis of certain criteria. Awards are often made. Top rated projects may qualify for competition at state, national or international levels. SEE "Science day", "Science talent search".

Science inspector - an employee of a local or national school administration. Visits classrooms, helps teachers with their work by providing suggestions, etc. Usually evaluates and reports on teachers' competence and effectiveness. SEE "Science supervisor", "Science co-ordinator".

Science major - a learner at secondary or higher level who is specialising in science.

Science museum - a place to which the public may come to see exhibits which illustrate the role of science in society.

Science process - SEE "Process of science".

Science seminar - a group meeting to discuss aspects of scientific knowledge, science education or research at an advanced level according to the professional interests of the participants. May be conducted by a teacher or a learner. Usually meets on a regularly scheduled basis, with topics announced in advance. May meet only on special occasions, or may be convened 'ad hoc'.

Science/society interface - those areas of public interest and concern in which science and technology impact upon national, civic, social, business, industrial, family and personal problems.

Science talent search - a competition to identify capable and highly motivated learners at secondary level. Usually involves the report of an individual science investigation and/or an examination. May also include an interview with professional scientists. May culminate in a science fair. SEE "Science fair", "Science day".

Science teacher - any person who teaches science at any level. Usually one who teaches in a classroom, but also included one who teaches in other settings.

Scientific attitude - a way of acting, or a personal feeling in which the values, processes and norms of science are dominant. Thus, for example, suspending judgement on a question or problem because there is insufficient evidence to make a decision one way or another.

Scientific literacy - an attribute of informed people which includes knowledge of things from science and technology which are important in contemporary culture and reflect an understanding of scientific enterprise both past and present. Also a level of those abilities and skills which enable one to read articles about science in the public press intelligibly, to use science in everyday life, and to understand contemporary issues in science and technology.

Scope and sequence - a brief plan for a relatively long range science curriculum (ages 5-11 or 5-18), in which certain topics or concepts are prescribed by age or grade level.

Second generation - 1. refers to those courses and/or textbooks which have been developed on the basis of feedback from classroom use of "new" programmes developed in the 1960's.

2. refers to those technological devices, such as computers, which have resulted from significant improvements of earlier devices. Usually refers to devices first made public shortly after the termination of World War II, and modified in the past decade. SEE "First generation".

Self-paced - refers to one form of individualized instruction in which the learner works through a fixed sequence of activities at his own rate. SEE "Learning activity package".

Seminar - SEE "Science seminar".

Separate sciences - a science curriculum organized around separate science disciplines, where each of the sciences is regarded as a proper school subject by itself, as in the case of botany, zoology, physiology, anatomy, etc. CONTRAST "Unified science education", "Integrated science education".

Sequence - a recommended order of courses in a programme or of units within a course, usually established to build understanding in a logical way.

Set - SEE "Kit".

Setted - refers to classes that have been grouped by ability in a given subject, such as science, but grouped differently for other subjects. CONTRAST "Streamed". SEE "Homogeneous group".

Significance - a measure of relative importance in interpreting science data. Can be estimated quantatively by certain statistical tests which indicate the probability that a given difference is due to something other than pure chance.

Simulation - an activity in which a real situation is represented by a simpler analog. For example, rolling a large number of dice can simulate radioactivity, if, when each time a "two" comes up that die is removed from the group, to symbolise its undergoing radioactive decay. May utilize a computer. Also includes group games and role play situations in which the interactions of learners represent the "reality" being studied. SEE "Role play", "Game".

Simulator - a device which represents a real object or situation, especially as its condition changes in response to changes in certain variables. Thus a computer can be a simulator of a river in which the temperature changes as a consequence of seasonal changes, industrial pollution, etc.

Slide-tape - one way of conveying individualized instruction. Comprises a set of projected photographic transparencies and an accompanying narrative on audiotape. Often the narration includes audible signals which indicate when to change slides.

Small-scale science - science courses developed expressly to allow the use of only small quantities of material. Most courses of this kind are in chemistry and are sometimes described as "semimicro".

Software - 1. printed material such as textbooks, laboratory manuals and tests used in conjunction with teaching. CONTRAST "Hardware".

2. materials such as programme and symbolic languages necessary in the operation of computers.

Sound-filmstrip - a series of pictures, for projection, joined in one continuous piece of film, and accompanied by a record, or audiotape, which contains a narration and an audible signal for advancing to the next picture. Some special equipment uses advance impulses that cannot be heard. SEE "Slide-tape".

Specific objective - an item, like "steam" or "the decimal notation", listed as part of a course of study. SEE "Aims", "Goal", "General objective".

Streamed - refers to school groups, such as classes, to which learners have been assigned according to some measure of general ability for all school subjects. SEE "Homogeneous group", "Setted". CONTRAST "Heterogeneous group".

Specific aims - SEE "Specific objective".

Stream table - a large basin 2 to 3m long, 1m wide and about 30 cm deep, with a drain at one end. Usually mounted on legs so that it slopes gently from one end to the other. In use it is partly filled with sand, and water is applied to the surface at one end. As the water flows out it erodes the sand, producing patterns that can be compared to those meanders observed in nature. Can also be used to study experimentally the action of waves on a beach and other phenomena.

Structure - 1. the specified organizational features of a teaching unit or course. May vary from having many specified features (high structure) to only a few (low structure).

2. the underlying framework of a scientific discipline, including its main concepts, theories, norms for research, etc.

Structured discovery - SEE "Guided discovery".

Study print - a relatively large picture, with a printed explanation of the scene on its back. Usually a photograph of some natural object, such as a cloud of one particular type, or the tools of oceanography. Often comes in sets depicting related objects, usually intended for use with younger teachers.

Summative evaluation - an evaluation of a course or programme in its entirety. Made at the conclusion of its period of initial development. Results may be used as a basis for subsequent revision. CONTRAST "Formative evaluation".

Supplies - those materials needed in teaching which are consumed in the learning process, and must be replaced on a regular basis.

Systems approach - a method of organizing individualized learning. Usually a series of learning activities prescribed for each individual learner and based on the results of a test of the specific objectives. Intended to make learning more efficient, by removing the need for studying things already known. Frequently uses a broad variety of learning modes, especially those that are media oriented. May use a computer to keep track of individual progress, and to prescribe the next activity.

Target - the specific group of learners for whom a given course, unit, or activity is intended. Also that particular group of teachers for whom a special in-service activity is intended.

Teaching method - the general and most common way of teaching used by a given teacher on a day-to-day basis. Sometimes one of several ways to organizing teaching on a given day. CONTRAST "Mode of learning", "Teaching strategy".

Teaching strategy - the intellectual approach used by a teacher in a given situation, regardless of the teaching method or mode of learning used. May be inductive or deductive. May incorporate differing levels or kinds of learner participation and decision making. Usually refers to the approach used in a single lesson or session. CONTRAST "Mode of learning", "Teaching method".

Teaching unit - SEE "Unit".

Team teaching - a situation in which several teachers share responsibility for the process of conducting a course or unit. Can be organized in several ways. Ideally, each member of the team is present at all class sessions. Often used in teaching unified or integrated courses when each team member has a background in a different science discipline.

Technology - the application of scientific knowledge to the general purpose of fulfilling an individual, community or national need. Thus, airplanes, insecticides, preserved food and cameras are direct products of technology. Often mistakenly equated to science by the general public.

Tentativeness - refers to the view that all science theory is subject to change as new data and thought occur.

Test - 1. a task or series of tasks in which the learner is called on to demonstrate knowledge of theories, principles, concepts, facts or skills in problem solving and/or manipulation of apparatus. Used in evaluating learner achievement, and also in evaluating the effectiveness of an activity, or course.

2. an experiment designed to check the acceptance of a hypothesis or detect the presence of a chemical.

Theme - an idea that recurs in many studies, units or courses, as in "The theme of how structure is related to function occurs in every chapter". Also an idea which serves as the principal organizer for a unit or module, as in "The theme of this unit is 'Cycles'".

Theory - an explanation that is useful in accounting for a large number of related phenomena and facts, as in "Atomic theory is usually used to explain chemical changes". Usually acknowledges change in the past, and is open to future change. Sometimes, in everyday conversation, is the equivalent of "hypothesis", as in "That is only a theory". SEE "Fact".

Ticker-tape timer - a device used to make a record of the amount of movement in small periods of time. Usually constructed so that a moving object pulls a narrow strip of paper under a small, regularly vibrating hammer, which makes a mark on the paper at the end of each period.

Trade-off - an idea which asserts that every technological effort, intended to gain some desirable end, is accompanied by one or more undesirable side-effects, which must be accepted if the original benefits are judged to be more valuable.

Traditional science - usually refers to the science taught in schools before the reforms of the 1960's.

Transition - a condition of a learner in the process of changing from one level of reasoning ability to the next higher one. In this condition, the learner sometimes shows characteristics of one stage, and, at other times, those of another stage. Important to consider in teaching especially to ages 11-18. SEE "Formal reasoning", "Concrete reasoning".

Trial - that period of time when a new programme or textbook is being tried for the first time. Often refers to the first version of printed instructional materials.

Try-out - SEE "Field test", "Trial".

Tutorial - a follow-up to a lecture or discussion in which a learner interacts with a teacher on a one-to-one basis. In science it may be used to develop problem solving skills, the interpretation of relatively complex theories, etc., so that the learner may do well on a subsequent test.

Undifferentiated science - SEE "Unified science" and "Integrated science".

Unified science education - an approach to science curriculum design which emphasizes those ideas that permeate all the separate sciences. Frequently results in a series of units, with interdisciplinary themes, where each unit ordinarily contains learning activities derived from many of the separate sciences. Usually applied in the age range of 5-18, but has also been used in post-graduate work for science teachers.

Unifying theme - an organizing theme for an instructional unit, especially suited for a unified science approach. SEE "Unified science education", "Organizing theme".

Unit - a collection of learning activities organized around a topic or theme. Usually an integral part of a course. Often begins with an introduction and ends with a test or other assessment activity. Activities within a unit may be sequenced, and may be placed in a sequence with other units.

Un-streamed - refers to learners assigned to classes in such a way as to include those of a wide range of ability in each class. SEE "Heterogeneous group".

Validity - a state of being well-grounded on principles and/or evidence. Able to withstand criticism and objection. Sometimes established by statistical procedures. In the case of science, tests which are valid are judged to measure what they claim to measure.

Values of science - those values of mankind on which science is based. Thought and opinion held collectively by professional scientists regarding their professional activities. The source of norms for scientific research and behaviour, as "Scientists value 'the questioning of all things' as necessary to initiate research".

Work - as used in science, the word 'work' has a special technical meaning. 'Work' is 'done' when the point of application of a force moves directly along or partially towards the direction along which the force is being applied. Thus, if a car is being towed, work is being done by 'the pull' on the car of the tow-rope. Work is also being done when a barge is towed along a canal by a horse or a tractor moving along the bank. In the second case, the point of application of 'the pull' moves only partially along the direction of the pull.

Worksheet - a form on which instructions are given to the learner and a space provided for some response by the learner, often connected with some type of laboratory or practical activity, usually submitted to the teacher for evaluation, sometimes limited to those forms prepared by the individual teacher. SEE "Guide-sheet".

Workshop - 1. a place where practical work is carried out using tools and equipment retained in the place.

2. a meeting of science teachers at which a product is developed. The product may be instructional materials or apparatus. Often, any meeting at which some type of physical activity (as contrasted to just listening and speaking) occurs. Sometimes any meeting of science teachers.

ABBREVIATIONS

AAAS American Association for the Advancement of Science

ACO African Curriculum Organization

ACS American Chemical Society

AESP Agriculture as Environmental Science Project (Israel)
AETS Association for the Education of Teachers of Science (USA)
ALECSO Arabian Educational, Cultural, and Scientific Organization

AP Advanced Placement

APBG Association Des Professeurs De Biologie Et Geologie (Association of Biology and Geology Teachers) (France)
ASCD Association for Supervision and Curriculum Development (USA)
ASE Association for Science Education (UK)

ASEP Australian Science Education Project
ASERA Australian Science Education Research Association
ASTEP Australian Science Teacher Education Project

AT Auto-Tutorial; Appropriate Technology

BICP Biomedical Interdisciplinary Curriculum Project (USA)

BIE Bureau International d'Education (International Bureau of Education)

BSCS Biological Sciences Curriculum Study (USA)

CAI Computer Assisted Instruction

CBA Chemical Bond Approach (USA)

CCC Council for Cultural Cooperation in Europe

CERI Centre for Educational Research and Innovation (International)

CHEM Chemical Education Materials Study (USA)

CIJE Citations in Journals of Education (USA)

COPES Conceptually Oriented Program in Elementary Science (USA)

CROASE Caribbean Regional Organization of Associations for Science Education

CXC Caribbean Examinations Council

ECCP Engineering Concept Curriculum Project (USA)

EJSE European Journal of Science Education

ERIC Educational Resources Information Center (USA)

ESCP Earth Sciences Curriculum Project (USA)

ES Essentia: Environmental Studies (USA)

ESS Elementary Science Study (USA)

FUSE Federation for Unified Science Education (USA)

GAST Ghana Association of Science Teachers

GPA Grade Point Average

HSP Human Sciences Program (USA)

IAC Interdisciplinary Approaches to Chemistry (USA)

ICASE International Council of Associations for Science Education

I-CLS Idea Centered Laboratory Science (USA)

ICSU International Council of Scientific Unions

IPN Institut für die Pädagogik der Naturwissenschaften (Institute for Science Education) (F.R. Germany)

IPS Introductory Physical Science (USA)

ISCS Intermediate Science Curriculum Study (USA)

ISIS Individualized Science Instructional Systems (USA)

JRST Journal of Research in Science Teaching (USA)

JSSP Junior Secondary Science Project (Australia)

LAP Learning Activity Package

LAMP Less Able Materials Project (UK)

MACOS Man: A Course of Study (USA)

MINNEMAST Minnesota School Mathematics and Science Teaching Project (USA)

NABT National Association of Biology Teachers (USA)

NAGT National Association of Geology Teachers (USA)

NARST National Association for Research in Science Teaching (USA)

NDEA National Defense Education Act (USA)

NSF National Science Foundation (USA)

NSTA National Science Teachers Association (USA)

NVON Nederlandse Vereniging Voor Het Onderwijs in de Natuurwetenschappen (Netherlands Association of Science Teachers)

OBIS Outdoor Biological Instructional Strategies (USA)

PSSC Physical Science Study Committee (USA)

RIE Resources in Education (USA)

S-APA (SAPA) Science - A Process Approach (USA)

SCIS Science Curriculum Improvement Study (USA)

SCISP Schools Council Integrated Science Project (UK)

SEASAME Southeast Asia Science and Mathematics Experiment

SEPA Science Education Program for Africa

SISCON Science in a Social Context (UK)

SSMA School Science and Mathematics Association (USA)

STEP Science Teacher Education Project (UK); Sequential Test of of Educational Progress (USA)

TOUS Test on Understanding Science

UNIPAC Unit Instructional Package

USMES Unified Science and Mathematics for Elementary Schools (USA)

WISCIP West Indian Science Curriculum Innovation Project